CLAIMS

What Is Claimed:

1. A method for simulating a multi-dimensional space, comprising:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model; and

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number.

2. The method of claim 1, further comprising assigning the unique values to each dimension based upon a prescribed index.

3. The method of claim 1, further comprising sampling the multiple variables of the multi-dimensional space and statistically analyzing the sampled multiple variables according to a prescribed error analysis.

4. The method of claim 1, further comprising sampling the multiple variables of the multi-dimensional space and performing numerical integrations upon the sampled multiple variables.

5. The method of claim 1, wherein each pseudo-random number R generated by the prescribed quasi-Monte Carlo model includes a floating point number having a value between 0.0 and 1.0, further wherein each dimension is characterized by a unique value based upon an index, the index equal to a total combinations of dimensional value points TC times a respective pseudo-random number R.

6. The method of claim 1, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, further wherein each dimension is characterized by a prescribed resolution S.

7. The method of claim 6, wherein the D dimension values are further characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension.

8. The method of claim 6, further comprising selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space.

9. The method of claim 8, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

10. A method for simulating a multi-dimensional space, comprising:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

11. A method for simulating trace impedance of a printed circuit board characterized by at least three dimensions of a multi-dimensional space, said method comprising:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model; and

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number.

12. The method of claim 11, further comprising assigning the unique values to each dimension based upon a prescribed index.

13. The method of claim 11, further comprising sampling the multiple variables of the multi-dimensional space and statistically analyzing the sampled multiple variables according to a prescribed error analysis.

14. The method of claim 11, further comprising sampling the multiple variables of the multi-dimensional space and performing numerical integrations upon the sampled multiple variables.

15. The method of claim 11, wherein each pseudo-random number R generated by the prescribed quasi-Monte Carlo model includes a floating point number having a value between 0.0 and 1.0, further wherein each dimension is characterized by a unique value based upon an index, the index equal to a total combinations of dimensional value points TC times a respective pseudo-random number R.

16. The method of claim 11, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, further wherein each dimension is characterized by a prescribed resolution S.

17. The method of claim 16, wherein the D dimension values are further characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension.

18. The method of claim 16, further comprising selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space.

19. The method of claim 18, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

20. Apparatus for simulating trace impedance of a printed circuit board, the printed circuit board characterized by at least three dimensions of a multi-dimensional space, said apparatus comprising:

a random number generator for generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

a mapping processor for mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

a value selector for selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

21. A method of manufacturing a printed circuit board comprising:

characterizing the printed circuit board by at least three dimensions of a multi-dimensional space; and

manufacturing the printed circuit board in accordance with a simulated trace impedance, the simulated trace impedance obtained by:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

22. A computer system, comprising:

a printed circuit board manufactured in accordance with a simulated trace impedance, said printed circuit board including impedance traces that characterize at least three dimensions of a multi-dimensional space of said printed circuit board , wherein said impedance traces include trace impedances obtained by:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.